Hannibal, Mo., river district.

The ice in the Mississippi River in this vicinity formed early, attained unusual thickness and broke up and passed out without doing any damage.

The first floating ice appeared at Hannibal on December 7 and the river became frozen above the Wabash bridge on December 9, without forming any gorge, worth mentioning. At this point the river continued frozen over until 4.45 a. m. February 16. People crossed the river on this ice as late as February 11.

Below the Wabash bridge the ice formed and extended out from the shores and closed about a mile below town on December 17. Most of this ice went out on December 20, but soon re-formed and by December 30 the river was entirely frozen over below as well as above the bridge, except a small air hole just below the bridge. Below the bridge, people crossed the river on the ice from December 30 to February 9. This ice broke up and moved out on February 14 and the ice above the bridge began moving out on February 16.

There was heavy floating ice in the river from February 16 to February 23, but from that time to March 6 only a little ice was observed.

The greatest thickness of ice observed was 17 inches on January 28. It probably was a little thicker during the first few days of February, but no measurements were obtained.

At other places in this river district the conditions were about the same as at Hannibal.—*B. L. Waldron, Meteorologist in Charge.*

Memphis, Tenn., river district.

The amount of ice passing through the Memphis district of the Mississippi River during the winter months of 1917–18, is believed to have been the greatest since the establishment of this station in 1871. Ice began moving past Memphis as early as December 13, 1917, and continued in varying amounts during most of the time until February 10, 1918. During December the river at times was nearly filled with moving ice, but not until the end of the month was there sufficient to interfere seriously with the movement of river craft, but on the 31st the ice became so heavy that only the largest boats attempted to run. Then on January 6, 1918, the ice gorged in a narrow stretch in the river near Richardson Landing about 50 miles above Memphis, causing a complete suspension of navigation to the north, but continued to southern points until January 17 when a portion of the Richardson gorge broke away, and this with the ice forming below the gorge filled the river from bank to bank, and on account of the low stage of water, a garge was formed about two miles below Memphis. For two or three days there was no movement in the ice at this place while the amount was constantly increasing from the flow from points above which, with the rapid increase in the water held back by the gorge, so increased the strain during the early morning of the 20th, that the gorge gave way and the whole mass moved out carrying with it four of the Lee Line steamers that were unable to reach a safe harbor on account of the ice congestion. Two of these steamers were crushed and sunk a few miles below Memphis while the remaining two were finally saved. Also a small steamer attached to the Mississippi River Commission fleet and one barge was sunk by the ice. From this time on to the end of January, 1918, only a moderate amount of ice passed Memphis as the Richardson gorge still held.

The Richardson Landing gorge extended a length of several miles, and at the point of formation reached from the river bed 4 to 10 feet above water level. At 12:30 p. m. February 4, 1918, this gorge gave way under the great pressure of added ice and water and seven hours later, about 7 p. m. the van of this ice gorge reached Memphis, filling the river from shore to shore with an immense mass of rough and jagged ice moving rapidly, some of the piled up cakes forming hummocks 10 to 15 feet in height. The Richardson Landing gorge held practically intact 29 days. On February 5, soon after midnight the great Osceola, Ark., gorge (see Fig. 8) that extended from a little below Osceola northward over 25 miles and first formed January 14, 1918—broke with a loud report that was heard for several miles. This ice reached Memphis at 9 a. m. and before noon the river was again filled with a turbulent mass of rapidly moving ice which imprisoned numerous small river craft, in all about 35 passing this station, some in perfect condition and some crushed and sin' ing. The craft passing here were: Twenty-one barges, a few laden but most of them empty; 2 wharf boats: 4 house boats: 1 dry-dock; 1 ferryboat; one pile driver; 1 tie loader; an unfinished hull of a steamer and a few others of undetermined character. The unfinished hull is said to have come from Paducah, Ky. It is thought that most of these craft were saved before reaching Helena as only a few passed that place. There were two barges loaded with logs, one of which was smashed on one of the bridge piers at Memphis, while the other passed on safely. Except the loss of the two Lee Line steamers and two small ones, the property of the Mississippi River Commission, there was no local loss or damage to river craft owned or controlled in the Memphis district. This was due to the fact that all local craft, except the fleet of Government dredge boats safely moored in their harbor below the two railroad bridges, were brought into the new canal that now passes in front of the city, an extension of Wolf River that formed a safe refuge against the moving ice and prevented the destruction of at least $600,000 worth of river craft. Total damage in this district $115,000.

The Weather Bureau records show that serious ice conditions prevailed in the Mississippi in this district during the winter of 1872–3, which at that time was said to have been the coldest and most severe winter in the last 30 years. On December 27, 1872, a gorge that had formed at Randolph, Tenn. (practically the same place as Richardson Landing where the gorge of this year occurred) broke and out of 20 steamers at the Memphis harbor, 8 were totally destroyed and 7 badly damaged. The Brown & Jones Coal Co. lost coal then valued at $150,000. On December 30, 1876, another gorge occurred at Randolph, Tenn., causing a suspension of navigation: and again in January, 1877, a gorge formed at the same place. In January, 1887, navigation was suspended for 10 days on account of ice gorges.—*S. C. Emery, Meteorologist in Charge.*

Vicksburg, Miss., river district.

Heavy floating ice began passing in the Mississippi River at Vicksburg during the night of January 20–21, 1918. On the 22d and 23d, the heavy ice was frozen together along each shore for about one-third of the way across, and the balance was moving. On the 24th, 25th, and 26th, the ice was all moving, and on the 27th, practically all had disappeared. Navigation was greatly impeded from January 21 to 25, inclusive. A little of the ice reached Natches, Miss., on January 24.

Heavy floating ice began passing on the night of February 9–10, and the flow of heavy ice practically ended during the night of 10–11. This was gorge ice from the Richardson and Osceola gorges above Memphis, Tenn. Navigation was impeded on the afternoon of February 10 by floating ice and débris.—*William E. Barron, Meteorologist in Charge.*

NORTHERN TRIBUTARIES OF OHIO AND LAKE ERIE DRAINAGE.

Wabash river district.

Ice formed in the river during the early days of December and by the 10th of the month the stream was frozen generally from source to mouth. Cold weather continued with very little interruption and by February 1 the ice was 13 to 14 inches thick in the extreme upper stream, 9 to 10 inches in the central portion, and 6 to 7 inches in the lower. After the first five days of February the weather became warmer, then thawing resulted, so that by the time the ice broke up, on February 12, it was from ½ to 1 inch less in the thicknesses than it was on the first of the month.

The ice broke up at Terre Haute, Ind., in the lower river late in the afternoon of February 11, but the general breaking up did not occur until the afternoon of February 12. On the morning of February 13 the stream was full of ice at all points. Gorging at some points occurred on the 13th and 14th, but this was slight and attended by little damage. In fact jamming and gorging did not reach a point where it caused any unusual concern; these conditions occurred in a much less degree than was anticipated.

By February 15 there was no ice in the upper river and this condition prevailed in the lower stream by the 19th. No ice was observed in the river at Terre Haute on the 17th and for 36 hours before there was only a small amount noticed.

In the upper stream in the vicinity of Bluffton a few shots of dynamite were used on February 11 and 12 with the view of protecting railroad and traction company bridges. No bridges were damaged, nor was any other material damage done, in the Wabash; a few small bridges that span some of the tributaries of the Wabash were damaged more or less, but no reliable information is available with respect to these.

It is estimated that $5,000 will cover all damage from ice in the entire valley.[1]—*W. P. Cade, Meteorologist in Charge.*

Fort Wayne, Ind., river district.

During the early part of December, 1917, the weather was specially favorable to the formation of ice, particularly between the 6th and 16th, and much ice formed during that period on the Maumee and its tributaries. Moderately high temperatures from December 19 to 24 resulted in considerable thawing and the ice lost considerably in thickness; but from the closing days of December, 1917, until February 5, 1918, the weather was unusually favorable to a rapid and substantial increase in the thickness of the ice cover. The ice attained its maximum thickness on February 4 or 5, and on these dates, except at Fort Wayne, where the Maumee did not freeze entirely across during the winter, the general thickness of the ice ranged from 20 to 25 inches.

[1] Conditions on White River in Indiana, were much similar to those on the Wabash.—*A. J. H.*

The snow cover at the close of January, 1918, was unusually large throughout the Maumee watershed, and moderately warm weather and frequent rains subsequent to February 7 resulted in intense thawing. The surface run-off was large, the streams responded rapidly with increased stages, and the ice cover diminished and disintegrated quickly. In the upper reaches of the Maumee the ice began to break up on the 11th, but in the lower sections of the valley disintegration did not begin until the 12th or 13th. Gorges formed quite generally at upstream points on February 11 or 12, and at places east of Fort Wayne on the 12th or 13th. The gorges began to break up, as a rule, on February 14, except in Maumee Bay, where the final break up did not occur until March 3.

There was no flooding due to gorges at points above Defiance, Ohio; but from Napoleon, Ohio, eastward to Toledo, Ohio, the lowlands along the Maumee were inundated. On February 14 the water from the Maumee backed up to 19.5 feet at Napoleon, or 7.5 feet higher than would have occurred under normal conditions. Gorged conditions at Toledo caused the river to be above dock line from February 15 to 18, the maximum stage being 8.5 feet above the normal.

Detailed statements regarding the various gorges follow:

Montpelier, Ohio, St. Joseph River.—The ice at Montpelier was about 25 inches thick; it began to break up on February 14, and by the morning of the 15th the ice had moved downstream; the channel was free of ice and no gorge formed.

Fort Wayne, Ind., St. Joseph River.—A gorge formed at Tennessee Avenue bridge during the night of February 12 and extended a considerable distance upstream; the ice was from 12 to 18 inches thick, and by the morning of February 13 the gorge had disappeared; no damage resulted.

Fort Wayne, Ind., St. Marys River.—During the night of February 11 the ice began to break up on the St. Marys River and a gorge formed at Clinton Street bridge. The jammed ice extended upstream to Swinney Park, a distance of more than a mile; the gorge broke up and moved out at 12:15 p. m. February 14. The ice ranged from 10 to 20 inches in thickness. There was no damage.

As far as can be ascertained the ice moved freely down stream between Fort Wayne and Defiance, Ohio.

Defiance, Ohio, Auglaize River.—Between February 13 and 15 several gorges formed in the Auglaize. The most important of the gorges formed above the power dam and extended about 1 mile upstream. This gorge moved out on the 15th.

Napoleon, Ohio, Maumee River.—During the night of February 12 the ice in the shallow waters around Dependence Dam and Florida broke up and began to move downstream, gorging about 2 miles west of Napoleon. About 9:30 a. m. of the 13th the ice began to move out at Napoleon and gorged at the islands 1¼ miles east of Napoleon. The gorge held until 2:30 p. m. of the 13th, when it started to move out; it then jammed at Texas, Ohio, the water backing up to Napoleon, where a stage of 19.5 feet was attained at 8 a. m. of the 14th. At 10 a. m. of the 14th the gorge broke up and moved down the river. The ice was very dense and ranged from 16 to 24 inches in thickness. Although the flood waters covered a considerable area in the vicinity of Napoleon, the damage sustained was slight, as precautions had been taken to remove movable property to a place of safety.

Mr. W. S. Currier, official in charge of the Weather Bureau office at Toledo, Ohio, has furnished the following statement regarding ice and gorged conditions there.

"Ice began to form here along the shores of Maumee River and Bay on December 6, and by the 9th the river and probably much of Maumee Bay were frozen over. By the 17th of December the river ice averaged 8 inches in thickness and was reported to be 10 to 12 inches on the bay, but on the 24th the river ice was partially broken, due to the movement of tugs, and it only ranged from 2 to 4 inches in thickness where it had not been broken. Maumee Bay ice was from 7 to 9 inches thick on the 24th, but it was covered with water. After December 24 the ice on Maumee River and Bay increased in thickness until about February 4, 1918, ranging from 9 to 12 inches on the river and bay on January 14, and from 12 to 16 inches on January 21, reaching a maximum on February 4 of 18 to 22 inches on the river and 24 inches or more on the bay.

"After February 7 there was a rather rapid decrease in the ice covering the river and a slower decrease on the bay, the range in thickness on the river being from 9 to 12 inches on February 12, and the break-up began on February 14, due to rains in the valley and the coming down of ice from above. The ice opposite and below the city did not move to any extent, except to gorge in places, for some time after the break-up, as the bay ice held firm and prevented such movement. Maumee Bay ice broke on March 2 and 3 and moved out, allowing the ice in the river which had not previously disintegrated to move out, and all the ice of consequence was gone by the afternoon of March 4.

"From the 15th to the 18th of February the water in the river was above the dock line, due to gorged ice, the extreme height being about 8.5 feet above normal, and some damage and much inconvenience resulted from the water on Water Street and the flooding of many cellars for several blocks from the river. By February 27 the packed ice had disintegrated to such an extent that there were many open places and the river channel was partially open down to near the bay."—*P. McDonough, Meteorologist in Charge.*

Columbus, Ohio, river district.

Notwithstanding the large quantity of ice that necessarily formed in the rivers of Ohio during the abnormally cold weather of the winter of 1917–18, it all passed out without damage of consequence at any point. In fact it would seem hardly possible for the rivers to clear themselves of ice with less damage. The ice began to break up and to move on February 9 and by the 12th was practically all out; at least all danger was past. The ice varied in thickness from about 12 to 20 inches.—*W. H. Alexander, Meteorologist in Charge.*

Dayton, Ohio, river district.

The Miami River and its tributaries became frozen on December 9, 1917, and were not free of ice until February 14.

The ice began breaking in the upper portion of the Miami February 9, and at Dayton on the 10th; and from the 10th to the 13th numerous gorges and ice dams formed in the main river and in the Stillwater.

On the 10th and 11th small gorges formed at Sidney, Ohio, one at the county bridge just south of the city and the other at the Baltimore & Ohio Railway bridge. The ice in these did not exceed 3 or 4 feet, and it passed out without doing any material damage.

A small gorge formed at Piqua against the unbroken ice, accumulating to a thickness of about 4 feet. This broke and passed out the night of the 10th without causing any marked rise in the water and without doing any damage.

On the 13th an ice dam formed at Tadmore, causing the water to rise 1 foot above the flood stage. Some farm land in the vicinity was flooded, but no damage resulted.

In the evening of the 10th the ice began collecting at Fifth Street, Dayton, Ohio, against a temporary bridge in use since the 1913 flood. About 9:30 a. m. of the 11th this structure gave way and was completely destroyed. The damage was not great, however, as the new permanent bridge was completed and ready for traffic about two days later.

About 10 a. m. of the 11th a gorge formed against the unbroken ice below the Main Street bridge, on which the gage is located, and held till about 1 p. m. This caused a rise of over 2 feet at the gage, but the ice passed out without doing any damage.

About 11 a. m. of the 12th a gorge formed at the Baltimore & Ohio bridge just above this city, and carried away a temporary structure which was in use while repairs were being made and one pier of the bridge. All traffic over the bridge was stopped for three days.

Several ice dams formed at West Milton on the Stillwater, beginning the morning of the 11th. The most important one was on the 12th and 13th. The dam extended for more than half a mile up and down the river and its thickness was estimated at 6 to 10 feet. At 5 p. m. of the 12th the water rose to a height of 17 feet which is 5 feet above the flood stage.

The dam went out the night of the 12th and the river fell quickly to a stage several feet below flood stage.

A few farms were flooded, but the damage was slight.—*R. F. Young, Meteorologist in Charge.*

ATLANTIC DRAINAGE.

SUSQUEHANNA RIVER.

Harrisburg, Pa., river district.

Some of the small streams on the Susquehanna River system became frozen during the latter part of November and by December 10 the river and its tributaries were generally icebound. The weather continued cold until near the end of the first week in February. January, 1918, was the coldest January at Harrisburg since the station was established, the mean temperature for the month being 19.1° or 9.6° below the normal. The ice on the streams increased gradually, the thickness on the rivers and creeks ranging from about 18 to over 36 inches. On account of the continued cold little or no snow water found its way into the streams. The "January thaw" that many people talk so much about did not occur and the snow continued to increase in the watershed. On January 30 the average depth of snow in the vicinity of Harrisburg was 24 inches, probably the greatest amount on the ground at any time in the last 30 years or more. The streets were packed with ice and snow to a depth of 2 feet or more and many of the narrow streets were impassable. Snow was piled along the curbs to a depth of 3 to 6 feet.

High temperature on February 7 caused the snow to decrease rapidly in depth, and by the 11th some streams began to rise. Ice movements began on the Juniata and Chemung Rivers on the night of February 12, that from the Juniata gorging at the mouth of the river near Duncannon. This gorge, which was 10 to 15 feet high, damaged the piers of the bridge at Juniata, destroyed two or three buildings and damaged others. As a